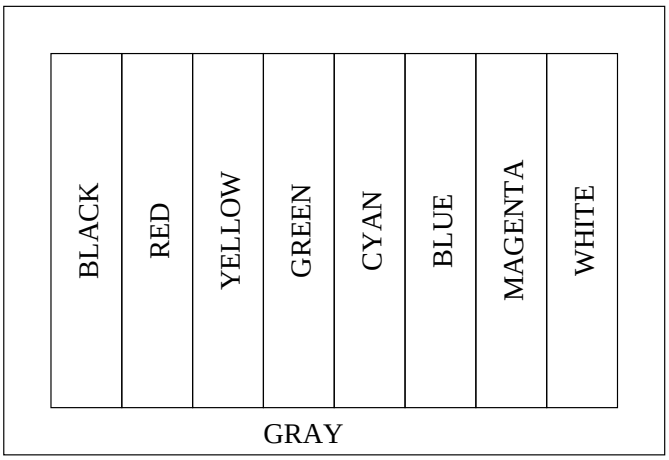
T-61.5100 Digital image processing, Exercise 10/07

Color image processing

1. (a) Consider any two valid colors c_1 and c_2 with coordinates (x_1, y_1) and (x_2, y_2) in the chromaticity diagram of Fig. 6.5 in the textbook. Derive the necessary general expression(s) for computing the relative percentages of colors c_1 and c_2 composing a given color c that is known to lie on the straight line joining these two colors.
   (b) A third color c_3 with coordinates (x_3, y_3) is then added. Derive the necessary general expression(s) for computing the relative percentages of c_1, c_2, and c_3 composing a given color c that is known to lie within the triangle whose vertices are at the coordinates of these three colors.

2. (a) Sketch the RGB components of the following image as they would appear on a monochrome monitor. (The color names are printed on each area in the image, see the true color image in p. 345 in the textbook). All colors are at maximum intensity and saturation. Consider the middle gray border as part of the image.
   (b) Sketch also the HSI components as they would appear on a monochrome monitor.



3. Derive the CMY intensity transformation function

$$s_i = kr_i + (1 - k), \quad i = 1, 2, 3 \quad (\text{for } C, M, Y),$$

from its RGB counterpart

$$s_i = kr_i, \quad i = 1, 2, 3 \quad (\text{for } R, B, G).$$

4. L^*, a^*, and b^* are defined in the CIELab colour coordinates (1976) in the following way:

$$L^* = 25(100Y/Y_0)^{1/3} - 16, \;\; 1 \leq 100Y \leq 100$$
$$a^* = 500[(X/X_0)^{1/3} - (Y/Y_0)^{1/3}]$$
$$b^* = 200[(Y/Y_0)^{1/3} - (Z/Z_0)^{1/3}]$$

$$(\Delta s)^2 = (\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2$$

Determine Δs when

(a) X, Y, and Z are changed by 5%?
(b) X, Y, and Z are changed by 10%?
(c) X_0, Y_0, and Z_0 are changed by 10%? X, Y, and Z are assumed to be constant.

What can be said about Δs?